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Project A Spatial Tests and Military Orienteering Performance in the Special Forces Assessment and Selection Program

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This research assessed the relationship between scores on new Project A tests of spatial ability and performance in the Special Forces Assessment and Selection (SFAS) program, including military orienteering (i.e., navigating over unfamiliar territory from a drop-off point to a prescribed destination). Candidates in two SFAS classes took the Project A Map, Orientation, and Maze tests. Researchers also used two measures of general cognitive ability and a measure of physical fitness as predictor scores. Criterion data were gathered as candidates proceeded through the SFAS program. The authors performed a series of univariate and multivariate analyses on these data. The major results indicate that (a) spatial scores are moderately related to scores on individual military orienteering tasks, (b) certain spatial test scores and scores on the Army Physical Fitness Test (APFT) lead to modest increases in the predictability of overall orienteering performance and graduation from the SFAS program, and (c) spatial, cognitive, and APFT scores do not lead to any appreciable improvement in the prediction of voluntary and involuntary attrition.
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The modest effects of our analyses indicate that SFAS performance is a function of spatial ability, physical fitness, and other, as yet unexplored, factors. Although the research described in this report does not provide a sufficient basis for recommending the use of Project A spatial tests as selection screens in the SFAS program, it does provide a basis for pursuing further research that might identify a role for these tests in the selection process.

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FOREWORD

The research described in this report is the result of a collaborative effort by the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) and the John F. Kennedy Special Warfare Center and School at Fort Bragg. The research was sponsored by the office of the chief psychologist of the Special Warfare Center and School and completed under the Selection and Classification Technical Area's research program on special screening tests for critical MOS.

The increased variety and complexity of Special Forces missions throughout the world have created a need for systematic, comprehensive procedures for assessing Special Forces candidates. In response to this need, the Special Warfare Center initiated the Special Forces Assessment and Selection (SFAS) program in June of 1988. ARI has a commitment to support Special Forces through research on the skills and aptitudes required in our elite forces.

The focus of this research is the relationship between spatial abilities and performance in the military orienteering phase of the Special Forces Assessment and Selection program. Spatial abilities were assessed using paper-and-pencil tests developed and validated by the Selection and Classification Technical Area as part of Project A. The Special Warfare Center designed the military orienteering performance tests and provided criterion data on candidates from two SFAS classes in 1989. This research is important because land navigation, one of the most difficult components of the Special Forces Qualification Course, is a critical skill in special operations.

The results of this research have been briefed to the sponsor. Comments from the Special Warfare Center indicate that this research is useful in providing an empirical basis for evaluating SFAS military orienteering events. Follow-up data will allow both spatial tests and military orienteering scores to be examined in relation to performance in the land navigation portion of the Special Forces Qualification Course.

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PROJECT A SPATIAL TESTS AND MILITARY ORIENTEERING PERFORMANCE IN THE SPECIAL FORCES ASSESSMENT AND SELECTION PROGRAM

EXECUTIVE SUMMARY

Research Requirement:

This research assesses the relationship between scores on new Project A tests of spatial ability and various aspects of performance in the Special Forces Assessment and Selection (SFAS) program. We hypothesized that spatial ability would be related to SFAS candidates' scores on six military orienteering exercises, each of which involves navigating over unfamiliar territory from a drop-off point to a prescribed destination. We also hypothesized that spatial, cognitive, and physical fitness scores would be related to graduation and various forms of attrition from the SFAS program.

Procedure:

Candidates entering two SFAS classes took the Project A Map, Orientation, and Maze tests. Other predictor scores available were two measures of general cognitive ability as well as a measure of physical fitness. Criterion data were gathered as candidates proceeded through the SFAS program. Due to attrition, only partial data were available for some candidates. We performed a series of univariate and multivariate analyses on these data.

Findings:

The major results of our analyses were as follows:

- Spatial scores are moderately related to performance on military orienteering.
- Certain spatial test scores, in combination with scores on the Army Physical Fitness Test (APFT), lead to modest increases in the predictability of (a) performance across all orienteering tasks, and (b) graduation from the SFAS program.
- Spatial, cognitive, and APFT scores do not lead to any appreciable increases in the predictability of voluntary or involuntary attrition.

Utilization of Findings:

The modest effects of our analyses indicate that performance in the SFAS program, including the military orienteering tasks, is a function of spatial ability and other, as yet unexplored, factors. Thus, although the present research does not provide a sufficient basis for recommending the use of Project A spatial tests as selection screens in the SFAS program at this time, it does provide a basis for pursuing further that research might identify a role for these tests in the selection process.

PROJECT A SPATIAL TESTS AND MILITARY ORIENTEERING PERFORMANCE IN THE SPECIAL FORCES ASSESSMENT AND SELECTION PROGRAM

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PROJECT A SPATIAL TESTS AND MILITARY ORIENTEERING PERFORMANCE IN THE SPECIAL FORCES ASSESSMENT AND SELECTION PROGRAM

Introduction

This research examines the relationship between Project A tests of spatial ability and performance on the Special Forces Assessment and Selection program (SFAS) military orienteering tasks. It also assesses the usefulness of spatial, intelligence, and physical fitness tests as predictors of certain SFAS outcomes (i.e., voluntary attrition, board evaluations, and successful completion of SFAS).

Background

The recent upswing in insurgent and low-intensity hostilities throughout the world has increased both the variety and complexity of Special Forces missions (Guest, 1988). These events, combined with pressures to more effectively use resources, have led to recent initiatives by the John F. Kennedy Special Warfare Center and School at Fort Bragg to enhance the assessment, selection, and training of Special Forces candidates.

Prior to mid-1988, there was only minimal pre-screening of candidates for Special Forces training. Volunteers who met the minimum time in service, physical fitness, and General Technical test score requirements were moved (along with their families) to Ft. Bragg to immediately begin the Special Forces Qualification Course. The Qualification Course is an intensive 18-to-48-week training program designed to prepare soldiers for the unique requirements and Military Occupational Specialties of the Special Forces branch. The high attrition rate in the Qualification Course (sometimes exceeding 50%; Guest, 1988) and the associated training and relocation costs prompted efforts to assess candidates' suitability for Special Forces prior to training.

In June of 1988, the Special Warfare Center implemented the Special Forces Assessment and Selection (SFAS) program to evaluate candidates' likelihood of success in Special Forces training and operations. The SFAS program is three weeks in length and involves a variety of assessment procedures, including measures of intelligence, personality, physical stamina, ability to work as a team member, and the basic military skills required in Special Forces. Successful completion of SFAS is a prerequisite for the Qualification Course.

Typically, between 40% and 60% of the entering candidates complete the SFAS program successfully (SFAS briefing; Special Warfare Center and School, 1989). Voluntary attrition accounts for almost half of the losses in SFAS. Candidates may withdraw from SFAS any time after the third day and many choose to do so, particularly during Phase I (days 1 through 10). Candidates classified as involuntary withdrawals include those who are dropped because their records are not in order, they fail to meet

prerequisites (e.g., pass the swim test), or they are injured or have a disqualifying medical condition. The majority of involuntary withdrawals, however, result from the evaluations of the SFAS review boards.

Seven-member review boards are convened twice during SFAS to discuss and evaluate candidates' records. The first board meets at the end of Phase I. Candidates who have performed poorly during Phase I are dropped from the program at this point. The second board meets on the last day of SFAS to review the records of candidates who completed the program but were rated "questionable" or "unsuitable" by the field evaluators. The board decides which of these candidates are eligible for the Qualification Course (Q Course). Candidates are described as having successfully completed SFAS only if they have been selected for continuation to the Q Course.

Evidence suggests that failures in land navigation account for a large proportion of the attrition from the Q course (Pleban, Allentoff, & Thompson, 1989). As a result, military orienteering is heavily emphasized in SFAS. There are six military orienteering events in all, four during the day and two at night, all occurring just prior to the end of Phase I. Performance on these events is measured as the time it takes candidates to navigate over unfamiliar territory from a drop-off point to a prescribed destination.

Basic navigational skills are clearly important to success in the military orienteering events; however, other personal characteristics are likely to affect performance as well. A variety of stressors (e.g., ambiguity, lack of performance feedback, sleep deprivation, nighttime exercises) are deliberately introduced into SFAS so that performance can be evaluated under conditions likely to prevail in an operational environment. Thus a candidate's ability to function effectively under stress and his motivation to succeed may be as important as navigational skills or spatial abilities in these events.

Research Purpose and Rationale

Three tests of spatial ability were administered to two SFAS classes in the spring of 1989 as part of a joint research effort by the Special Warfare Center and the U.S. Army Research Institute (ARI). These paper-and-pencil tests were originally developed for use in Project A, ARI's effort to develop and validate a comprehensive battery of personnel tests. The spatial tests were designed to measure cognitive ability domains not covered by the Armed Services Vocational Aptitude Battery (ASVAB), the instrument currently used by the Army for its selection and classification decisions (Peterson, 1987). The three tests administered to SFAS candidates - Map, Orientation, and Maze - were those that appeared especially likely to tap

abilities important to success in the SFAS military orienteering events.

Previous research has shown that the Project A spatial tests are related to certain types of orienteering or navigation skills. For example, Busciglio (1990) found that the spatial tests were moderately useful for incrementing the validity of the ASVAB in predicting two pertinent hands-on criterion measures: (1) navigation - the ability to "plan or execute movement between points over unknown terrain" (Campbell, 1988, p. 80); and (2) determining grid coordinates of a point on a map using the military grid reference system.

The first set of analyses reported here focuses on the relationships between spatial test scores and (a) military orienteering times and ratings, (b) military orienteering composite scores, and (c) overall performance across all six events. In the remaining analyses, SFAS outcome categories are used as the dependent variables in exploratory discriminant and multiple regression analyses. The discussion of the results focuses on the possible utility of spatial tests as screening criteria for SFAS.

Method

Sample

There were 571 candidates (85% enlisted, 15% officer) admitted to the two SFAS classes (3/89 and 4/89) comprising the initial sample. Of those admitted, 79 candidates were dropped during the first three days of the program because their records were not in order, they failed to meet the prerequisites (e.g., failed the swim test), or they had a disqualifying medical condition. These candidates were excluded from all analyses, leaving an initial analysis sample of 492.

The analyses designed to predict final SFAS outcome categories are based on data from all 492 candidates who were still in SFAS on the fourth day (i.e., were not dropped for reasons mentioned above). Figure 1 illustrates the flow of candidates through the program and indicates the number of candidates in the different SFAS outcome categories.

The sample for the military orienteering analyses consisted of all candidates still present for each event. Because of voluntary attrition prior to and during the military orienteering events, sample sizes dropped from 473 for the first event (MO I Day) to 400 for the last event (MO IV). Table 1 shows the number of candidates from each class who participated in each military orienteering event, as well as the number still in the program at the end of Phases I and II.

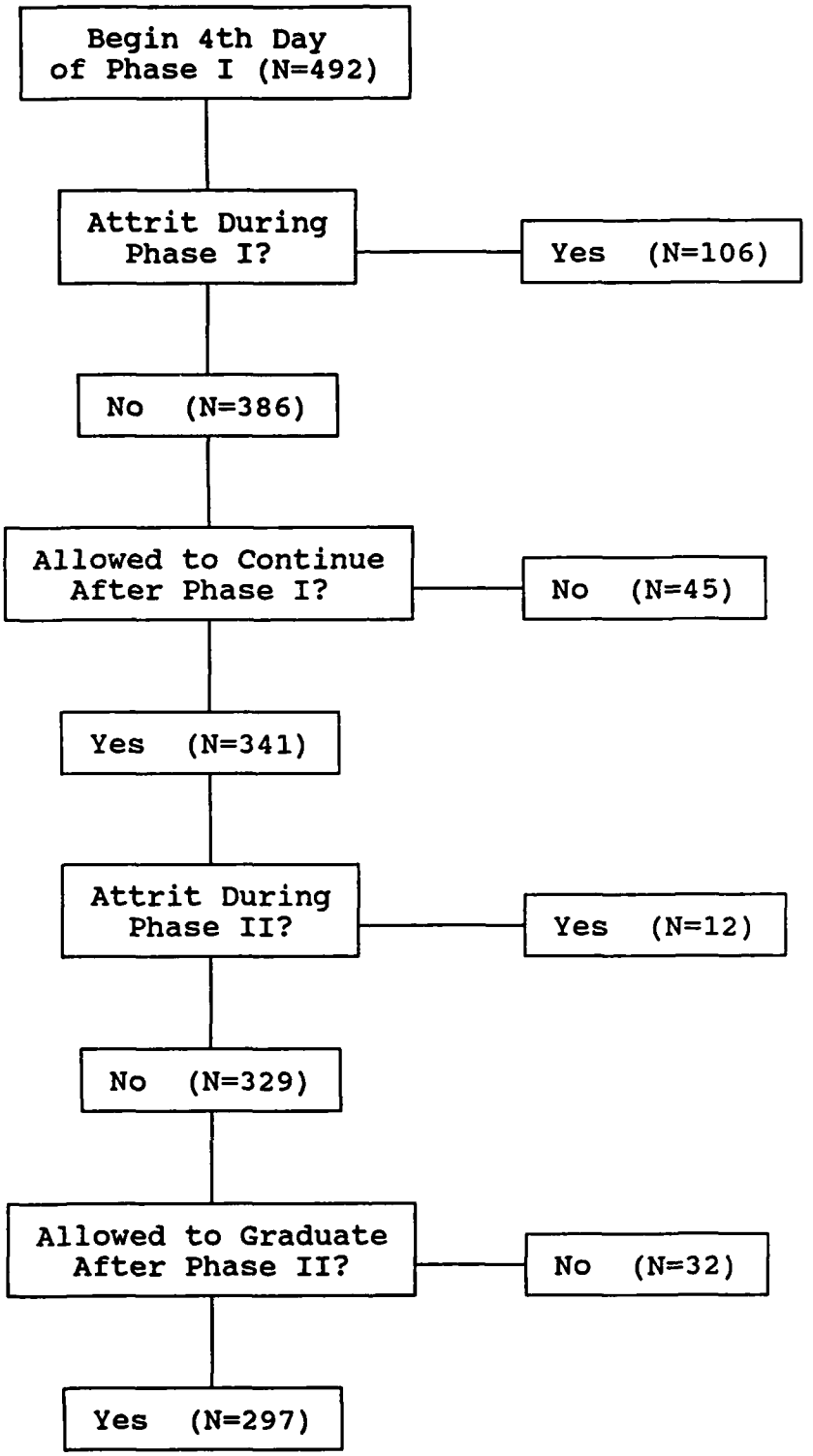

Figure 1. Numbers of individuals at various points in combined 3/89 and 4/89 SFAS classes.

Table 1

Number of Individuals Completing Various Stages of 3/89 and 4/89 SFAS Classes

Class	Spatial Tests[b]	Military Orienteering Tasks[a]						End of Phase I	End of SFAS
		I	I(NT)[c]	II	II(NT)[c]	III	IV		
3/89	259	249	246	235	228	217	203	195	161
4/89	233	224	221	216	211	208	197	191	168
Total	492	473	467	451	439	425	400	386	329

[a] Sample sizes shown are for ratings; two individuals in the 4/89 class had ratings on all six tasks but no time scores.

[b] Sample sizes are the numbers of candidates who were still in the SFAS program after the third day (i.e., those not dropped for failure to meet the prerequisites).

[c] Denotes nighttime events.

Predictors

Spatial tests. A researcher employed by the Special Warfare Center administered the three spatial ability tests to candidates in the 3/89 and 4/89 classes at the end of the second day of the program.

The Map test measures the ability to "maintain one's bearings with respect to points on a compass and to maintain appreciation of one's location relative to landmarks in the environment" (Peterson, 1987, p. 3-29). On the test, the examinee works with a schematic map that contains familiar landmarks (e.g., forest, lake). Given the direction of one landmark to another, the examinee must figure out the direction from a given third landmark to a specific fourth one. The Map test consists of 20 items and has a 12 minute time limit.

The Orientation test measures one's ability to mentally rotate objects. Examinees are required to figure out what an object will look like after it is rotated in the plane of the page, and they must infer the degree and direction of this rotation. The Orientation test consists of 24 items and has a 10 minute time limit.

The Maze test measures the ability to "visually survey a complex field to find a particular configuration representing a pathway through the field" (Peterson, 1987, p. 3-5). Each item is a maze with a number of entrances and exits. Subjects must

determine which one of the entrances will lead to an exit. Examinees have 5 1/2 minutes to complete the 24 item test.

Tests of General Cognitive Ability. The two cognitive measures used in the analyses were the Wonderlic Personnel Test and the General Technical (GT) composite (Arithmetic Reasoning + Verbal Ability) of the Armed Services Vocational Aptitude Battery (ASVAB). The Wonderlic test was administered along with the spatial tests at the end of the second day of SFAS. The GT scores were reported by candidates on the background data questionnaires filled out on the first day of the program.

Test of Physical Fitness. The Army Physical Fitness Test (APFT) was administered to candidates during the first day of SFAS. Scores on the APFT are a function of performance on three activities: situps, pushups, and a 4-mile run. Standards for 17-21 year-olds are used to obtain scores ranging from 0 to 300 for all candidates regardless of age.

Criterion Measures

Military Orienteering Scores. The military orienteering events take place between the seventh and tenth days of SFAS, immediately prior to the end of Phase I. On the seventh and eighth days, daytime events (MO I Day, MO II Day) are followed by nighttime events (MO I NT and MO II NT). The third (MO III) and fourth (MO IV) events take place on the ninth and tenth days, respectively.

Candidates normally receive two scores on each of the six military orienteering exercises: a time score (recoded into minutes for the analyses) and a summary performance rating (3=Outstanding; 2=Satisfactory; 1=Unsatisfactory) based on the time score. In some cases, however, candidates fail to complete an event (e.g., they get lost, give up, or exceed the maximum time and are picked up). When this occurs, the individual receives an unsatisfactory rating for the event and no time score is recorded. In order to make the analyses of time scores comparable to those of the ratings, we attempted to use the same (or nearly the same) sample with each. Thus, individuals who failed to complete an event were assigned a time score equal to the maximum actual score for the event, plus five minutes.

SFAS Outcomes. Exploratory analyses were conducted to assess the usefulness of spatial, general cognitive, and physical fitness test scores for classifying candidates into groups representing different outcome categories, as follows:

(a) voluntary withdrawals vs. all others,
(b) dropped by Phase I board vs. allowed to continue,
(c) dropped by Phase II board vs. selected for Q Course, and
(d) successfully completed SFAS vs. did not successfully complete SFAS for any reason.

Hypotheses and Data Analysis Procedures

Four basic research questions are addressed in the analyses:

1. Is spatial ability, as reflected in the spatial test scores, related to performance on the six individual military orienteering events?

2. Are spatial test scores related to composite military orienteering scores derived by combining events on the basis of their factor structure?

3. Can spatial test scores, in combination with physical fitness scores, predict the overall level of performance across all military orienteering events?

4. Do spatial test scores enhance the ability to predict overall performance in SFAS when used in conjunction with measures of intelligence and physical fitness?

Question 1. Underlying the first research question is the hypothesis that spatial test scores are related to ratings and time scores on the individual military orienteering events. We used one-way Analyses of Variance (ANOVAs), T-tests, and zero-order correlations to assess the relationships between the spatial tests and the MO rating and time scores.

Question 2. The second research question concerns the dimensionality of the individual orienteering scores and the possibility that the spatial tests may be differentially related to composite scores reflecting different dimensions. The first step in the analysis was to factor analyze (a) the time scores for all events and (b) the ratings for all events. Unit-weighted composite scores reflecting the underlying factors were then computed. Univariate correlations and backward stepwise multiple regression analysis were used to assess the relationships between spatial test scores and these composites.

Question 3. For the third research question we explored the usefulness of the spatial tests for predicting satisfactory completion of all the orienteering exercises. Three groups were created on the basis of criteria used by SFAS evaluators to summarize performance across all military orienteering events. We employed multiple discriminant analysis to examine the ability of spatial test scores to correctly classify candidates into three criterion groups.

Unlike the analyses above, the unsuccessful group included those who dropped out of the program during Phase I, and thus had missing scores on one or more orienteering events. Preliminary analyses indicated that the vast majority of these dropouts voluntarily attrited and that the APFT was the only measure to

significantly predict voluntary attrition. We therefore amended this research question to include physical fitness. We also conducted an analysis using spatial scores alone, but the effect sizes were not as great.

Question 4. The last research question concerns the extent to which spatial test scores contribute to the prediction of SFAS outcomes. Specifically, are measures of spatial ability, in combination with the measures of general cognitive ability and physical fitness, useful for predicting voluntary attrition, Phase I and II board actions, and successful completion of SFAS? We used a series of univariate t-tests and multiple discriminant analyses to explore these relationships.

Results

Descriptive Statistics

Table 2 shows descriptive statistics and intercorrelations for the predictors used in this research. Tables 3 and 4 show the same statistics for the military orienteering ratings and time scores, respectively, as well as correlations between the orienteering scores and successful completion of SFAS. The data on time scores in Table 4 are pertinent only to individuals who completed each task. (Mean time scores have been omitted for security reasons.)

Table 2

Descriptive Statistics and Intercorrelations for Predictors

				Correlation with:				
Predictor	Mean	SD	N	(1)	(2)	(3)	(4)	(5)
(1) Map	12.45	5.24	492	--				
(2) Orientation	15.45	6.18	492	.50*	--			
(3) Maze	18.55	3.77	492	.42*	.49*	--		
(4) Wonderlic	24.89	5.93	491	.65*	.45*	.29*	--	
(5) GT[a]	118.47	7.50	456	.33*	.19*	.14*	.49*	--
(6) APFT	232.58	26.07	490	.06	.06	-.11*	.07	.09

Note. * $p<.05$.

[a] Excludes two scores of "0" on the data set.

Question 1: Relationships Between Spatial Scores and Military Orienteering (MO) Ratings and Times

MO Ratings. We began by performing a series of one-way ANOVAs, with Tukey and Scheffe posthoc tests, to assess

Table 3

Descriptive Statistics, Intercorrelations, and Correlations with SFAS Graduation for Military Orienteering Rating Scores

Ratings on:	Mean	SD	N	Correlation with: (1)	(2)	(3)	(4)	(5)	(6)
(1) I Day	1.91	0.50	473	---					
(2) I Night	2.13	0.55	467	.23	---				
(3) II Day	1.77	0.42	451	.24	.19	---			
(4) II Night	1.90	0.40	431	.18	.15	.18	---		
(5) III	1.79	0.43	425	.19	.21	.25	.49	---	
(6) IV	1.83	0.39	400	.22	.13	.18	.28	.28	---
(7) Graduation				.27	.25	.27	.25	.33	.37

Note. All correlations significant at $p<.05$. Graduation coded 1 for yes and 0 for no.

Table 4

Descriptive Statistics, Intercorrelations, and Correlations with SFAS Graduation for Military Orienteering Time Scores

Times[a]:	SD	N	Correlation with: (1)	(2)	(3)	(4)	(5)	(6)
(1) I Day	46.7	437	---					
(2) I Night	38.6	433	.20	---				
(3) II Day	35.1	401	.23	.21	---			
(4) II Night	39.5	402	.18	.13	.26	---		
(5) III	47.4	389	.11	.21	.30	.33	---	
(6) IV	68.2	341	.18	.13	.29	.23	.35	---
(7) Graduation			-.25	-.19	-.28	-.19	-.27	-.26

Note. All correlations significant at $p<.05$. Sample sizes are the number of individuals completing each event. Graduation coded 1 for yes and 0 for no. Means omitted for security reasons.

[a] in minutes.

differences in the mean spatial scores of groups rated 3 (=Outstanding), 2 (=Satisfactory), and 1 (=Unsatisfactory) on the six orienteering tasks. As shown in Table 5, no candidates received Outstanding ratings on Task II and very few (too few to yield reliable results) were given the highest rating on Tasks III and IV. Consequently, for Tasks III and IV, the spatial test scores of the Outstanding performers were combined with those of the Satisfactory performers. For Tasks I-Day and I-Night, the

Table 5

Mean Spatial Scores of Groups Rated 3 (=Outstanding), 2 (=Satisfactory), and 1 (=Unsatisfactory) on Individual Military Orienteering Tasks

Group Ratings on Tasks	Mean Spatial Scores Map	Orientation	Maze
Task I (Day)			
3 (N=40)	14.1	17.0	19.5
2 (N=349)	12.9	16.0	18.8
1 (N=84)	9.8	12.5	17.3
Task I (Night)			
3 (N=104)	13.4	16.8	19.4
2 (N=318)	12.5	15.5	18.6
1 (N=45)	10.1	12.6	16.2
Task II (Day)			
3 (N=0)	----	----	----
2 (N=346)	13.2	16.0	18.7
1 (N=105)	9.9	13.4	18.1
Task II (Night)			
3 (N=16)	14.1	17.1	19.4
2 (N=363)	12.6	15.6	18.7
1 (N=60)	11.5	14.2	17.5
Task III			
3 (N=4; combined with Group 2)			
2 (N=330)	12.9	16.0	18.7
1 (N=95)	10.9	13.7	18.1
Task IV			
3 (N=2; combined with Group 2)			
2 (N=330)	12.9	15.9	18.9
1 (N=70)	10.5	13.7	17.1

Note. Sample sizes are the numbers of individuals in each group with nonmissing ratings. Means with nonsignificant differences (Tukey and Scheffe tests) are connected with a vertical line.

mean spatial scores of the Outstanding and Satisfactory groups were not significantly different from each other, but were significantly higher than the mean scores of the Unsatisfactory group. These results suggested that it was appropriate to combine individuals with Outstanding and Satisfactory ratings into one group for subsequent analyses. This decision is also

legitimate if the anticipated operational usage of the spatial tests is to screen out potentially unsatisfactory performers.

Table 6 shows descriptive statistics and the results of t-tests on the mean spatial scores of the two resulting groups: Satisfactory (including those with Outstanding ratings) and Unsatisfactory. In 14 of the 18 comparisons, spatial test scores for the Satisfactory group were significantly higher than scores for the Unsatisfactory group. All three spatial tests were significantly related to three military orienteering tasks: Task I Day, Task I Night, and Task IV. The Map and Orientation tests were significantly related to ratings for all events except Task II night.

MO Time Scores. Table 7 shows correlations between the Map, Orientation, and Maze tests and times (in minutes) on the six military orienteering tasks. For this analysis, candidates who did not complete a task were assigned a time score equal to the highest actual time, plus five minutes. As was the case with the ratings, there was strong evidence that spatial ability is related to military orienteering skills. Seventeen of the 18 correlations were significant in the predicted (negative) direction; that is, soldiers with higher spatial scores completed the military orienteering exercises in less time.

Question 2: Spatial Tests and Composite MO Scores

Factor Analysis of MO Ratings and Times. To assess more general relationships between spatial scores and military orienteering performance, the individual time and rating scores were factor analyzed and formed into unit-weighted composites. For both ratings and time scores, the mineigen (=1) and scree criteria identified single factor solutions accounting for 33.9 and 43.9 percent of the common factor variance, respectively (see Table 8). These results generally suggest that a common set of abilities underlies performance on all six tasks.

Predicting MO Composite Scores. Based on the factor analytic results above, we formed "Rating" and "Time" composites by summing across all six individual scores. Thus, only candidates with scores on all events were included in these analyses. Table 9 shows correlations between the spatial tests and the two military orienteering composite scores. As shown, all three spatial tests had significant correlations with both composites.

To determine which of the spatial tests contributed uniquely to the prediction of the composites, we performed backward stepwise regression analyses using the composites as the predicted variables and scores on the Map, Orientation, and Maze tests as predictors. In this procedure, all predictors were entered into the prediction equation as a block. Nonsignificant

Table 6

Descriptive Statistics and T-Test Results for Spatial Test Scores of Groups Rated Satisfactory and Unsatisfactory on Individual Military Orienteering Tasks

	Groups						
	Satisfactory			Unsatisfactory			
	M	SD	N	M	SD	N	t
Task I (Day)							
Map	13.00	4.92	389	9.83	5.95	84	4.56***
Orientation	16.10	6.00	389	12.55	6.37	84	4.87***
Maze	18.87	3.55	389	17.26	4.44	84	3.10**
Task I (Night)							
Map	12.71	5.17	422	10.09	5.53	45	3.21**
Orientation	15.80	6.13	422	12.60	6.17	45	3.32**
Maze	18.81	3.54	422	16.22	5.00	45	3.38**
Task II (Day)							
Map	13.17	4.87	346	9.92	5.77	105	5.23***
Orientation	16.02	6.10	346	13.44	6.23	105	3.79**
Maze	18.72	3.73	346	18.10	3.84	105	1.48
Task II (Night)							
Map	12.64	5.19	379	11.47	5.48	60	1.62
Orientation	15.70	6.12	379	14.23	6.58	60	1.71
Maze	18.74	3.74	379	17.53	3.91	60	2.31*
Task III							
Map	12.95	5.02	330	10.87	5.71	95	3.43**
Orientation	16.03	6.09	330	13.71	6.35	95	3.25**
Maze	18.72	3.78	330	18.06	3.84	95	1.50
Task IV							
Map	12.92	5.06	330	10.53	5.65	70	3.52**
Orientation	15.86	6.07	330	13.69	6.63	70	2.68**
Maze	18.91	3.69	330	17.10	4.09	70	3.66**

Note. *** p<.0001. ** p<.01. * p<.05.

Sample sizes are the numbers of individuals in each group with nonmissing ratings. Ratings of 3 (=Outstanding) and 2 (=Satisfactory) were considered Satisfactory; ratings of 1 were Unsatisfactory.

Table 7

Correlations Between Spatial Test Scores and Individual Military Orienteering Time Scores (in minutes)

Orienteering Task	N[a]	Predictor		
		Map	Orientation	Maze
Task I (Day)	471	-.25***	-.21***	-.15**
Task I (Night)	465	-.20***	-.21***	-.22***
Task II (Day)	449	-.27***	-.22***	-.10*
Task II (Night)	437	-.11*	-.08	-.12**
Task III	423	-.22***	-.23***	-.11*
Task IV	398	-.20***	-.16**	-.25***

Note. *** p<.0001. ** p<.01. * p<.05.

[a] Individuals with nonmissing time scores. All candidates starting but not completing a task were assigned a score equal to the maximum actual time for each event, plus 5 minutes.

Table 8

Varimax Rotated Factor Patterns in Military Orienteering Scores

Score	Ratings (N=400)		Times (Minutes) (N=398[a])	
	Loadings	h^2	Loadings	h^2
Task I (Day)	.58	.34	.65	.43
Task I (Night)	.52	.27	.62	.39
Task II (Day)	.58	.33	.66	.44
Task II (Night)	.58	.34	.65	.42
Task III	.62	.38	.69	.48
Task IV	.61	.37	.69	.48
Eigen Values	2.03		2.64	

[a] Numbers of individuals with scores on all six tasks. Two individuals had ratings on all tasks, but no time scores.

Table 9

Correlations Between Spatial Test Scores and Military Orienteering Composite Scores

		Predictor		
Composite Scores	N[a]	Map	Orientation	Maze
Rating	400	.33***	.30***	.24***
Time	398	-.32***	-.29***	-.26***

Note. *** p<.0001. ** p<.01. * p<.05.

[a] Numbers of individuals with scores on all six tasks. Two individuals had ratings on all tasks, but no time scores.

predictors were then removed one at a time, based on their individual contribution to the overall prediction. This process continued until all predictors remaining in the equation were individually significant at a certain alpha level (.05), and thus made a unique contribution to the prediction.

The results of the backward stepwise regression analyses are summarized in Table 10 and indicate that the Map and Orientation tests were significant predictors of both composites, while the Maze test did not contribute uniquely to the prediction of either composite. The significant spatial predictors together accounted for 12.9% of the variance in the Rating composite and 12% of the variance in the Time composite.

Table 10

Summary of Regression Analyses for Predicting Military Orienteering Composite Scores from Spatial Test Scores

Composite Score	Significant Spatial Predictor(s)	R^2
Rating	Map, Orientation	.129
Time	Map, Orientation	.120

Note. Significant spatial predictors are those with semi-partial correlations which are significant at the alpha=.05 level.

Question 3: Predicting Overall MO Performance from Spatial and PT Scores

Criterion groups. The last analysis of the relationships between spatial and military orienteering scores was an examination of the usefulness of the spatial tests as predictors of overall performance across all six orienteering events. For this analysis, individuals were placed into one of three criterion groups:

(1) Good (N=198) - These individuals received ratings of at least satisfactory on all six exercises.

(2) Okay (N=156) - These individuals completed all tasks and had unsatisfactory ratings on only one or two.

(3) Poor (N=138) - These individuals received more than two unsatisfactory ratings and/or did not complete all six exercises.

Unlike the analyses above, the sample used here included (in group 3 Poor, only) those who dropped out of SFAS prior to and during the military orienteering events, and thus had missing ratings on one or more exercises. Preliminary analyses indicated that the vast majority of program dropouts voluntarily attrited during Phase I and that the APFT was the only measure to significantly predict voluntary attrition. We therefore decided to include the APFT in this analysis. We also conducted an analysis using spatial scores alone, but the effects were not as strong as those reported below.

We used a backward stepwise discriminant analysis to determine an optimal weighted combination (or discriminant function) of spatial and APFT scores for classifying candidates into one of the three criterion groups. This procedure is similar to the backward stepwise analysis described above in that a predictor must make a unique contribution to the prediction in order to be retained in the final equation. However, here the predicted variable was categorical - i.e., membership in either the Good, Okay, or Poor group. The results in Table 11 show that Map, Maze, and APFT individually accounted for significant proportions of unique criterion variance.

After the stepwise procedure, we performed a discriminant analysis to determine the classification efficacy of the optimal discriminant function using the Map, Maze, and APFT tests. This procedure first determined hypothetical "cut scores" on the discriminant function, then used them to predict which individuals would be in each of the three groups. Since these cut scores were chosen to maximize agreement between predicted and actual membership in the three groups, the classification

Table 11

Spatial and APFT Tests as Predictors of Performance Across All Military Orienteering Tasks

	Groups						
	Good (N=198)		Okay (N=156)		Poor (N=138)		
Predictor	M	SD	M	SD	M	SD	Partial R^{2a}
Map	14.01	4.36	11.54	5.50	11.25	5.58	.034**
Orientation	16.77	5.71	15.03	6.26	14.01	6.40	NS
Maze	19.26	3.43	18.32	4.01	17.80	3.82	.014*
APFT	239.45	23.14	230.74	26.12	224.83	27.58	.058***

Note. *** p<.0001. ** p<.01. * p<.05. One individual in each of the Good and Okay groups had no score on APFT.

[a] Shown for significant predictors after elimination of nonsignificant predictor, which is noted as NS.

efficacy is an indication of the maximum utility of the Map, Maze, and APFT tests as predictors of performance.

Table 12 shows this classification efficacy (i.e., extent to which the function correctly predicts group membership). As can be seen, the function is quite useful for predicting Good performance but is less accurate in predicting Okay and Poor performance. That is, 152 of the 197 Good performers (or 77.2%) were correctly classified. However, only 31 (20%) of the 155 Okay performers and 38 (27.5%) of the 138 Poor performers were correctly classified. Also, the function overpredicts Good performance, incorrectly assigning more Okay and Poor performers to the Good performance group than to the correct groups.

The far right-hand column of Table 12 shows the combined numbers of predicted Good and Okay performers. If candidates were admitted to the SFAS on the basis of Okay-or-better predicted performance, 394 of the 490 in the sample would have been admitted. Of these, 172 (43.7%) would have been Good performers and a total of 294 (74.6%) would have been Okay-or-better. Both these percentages are higher than the actual rates of Good (197/490=40.2%) and Okay-or-better (352/490=71.8%) performance. At the same time, of the 96 individuals not selected, a large percentage (58/96=60.4%) would have been Okay-or-better performers if admitted.

Table 12

Classification Efficacy of Discriminant Function Using Map, Maze, and APFT Scores To Predict Performance Across All Military Orienteering Tasks

		Predicted Group				Combined
		Poor	Okay	Good	Total	Okay+Good
Actual Group	Good	25	20	152	197	172
	Okay	33	31	91	155	122
	Poor	38	33	67	138	100
	Total	96	84	310	490	394
Actual % Good		26.0	23.8	49.0	40.2	43.7
Actual % Okay+Good		60.4	60.7	78.4	71.8	74.6

The operational use of this discriminant function (or any other described below) therefore involves a trade-off between a higher percentage of satisfactory performers admitted and a certain number of "false negatives," or individuals incorrectly screened out. This issue will be expanded upon in the Discussion section.

Question 4: Predicting SFAS Outcomes from Spatial, PT and Cognitive Ability Scores

The last group of analyses dealt with the usefulness of the spatial, general cognitive, and physical fitness tests as predictors of different SFAS outcomes. For each of these analyses, t-tests on the mean test scores of the groups involved (e.g., voluntary attrition vs. remaining in the program) were performed. We then used a backward discriminant analysis to determine an optimal combination of spatial, cognitive, and fitness scores for classifying candidates into one of the two groups. Finally, we employed a discriminant analysis on the significant predictors to determine the classification efficacy of this discriminant function.

Voluntary Attrition from SFAS Program As shown in Figure 1, 118 candidates attrited from the SFAS program during Phases I and II combined. Since the focus here was on voluntary attrition, individuals who involuntarily withdrew or dropped out of the program for medical reasons were not included in the analysis. Additionally, since the number of soldiers who attrited for any

reason in Phase II was very small (N=12), we decided to combine all voluntary withdrawals into a single group. The 93 individuals who voluntarily withdrew at any point were included in the "attrited" group; those individuals present at the Gate I and Gate II evaluations (whether selected or not) were considered to have "remained."

Table 13 shows that the Army Physical Fitness Test was the only significant predictor of voluntary attrition. The classification efficacy of a discriminant function using the APFT is shown in Table 14. As can be seen, the function predicted that all individuals would remain in the program; that is, it was unable to identify any of the soldiers who did in fact voluntarily attrit. Even though candidates who remained in the program had significantly higher scores on physical fitness, the difference was not great enough to have any predictive utility in the sample analyzed.

Phase I Board Evaluation. For these analyses, the 341 individuals selected to continue in the SFAS program after Phase I were considered satisfactory and the 45 remaining in the program at the end of Phase I but not selected for continuation were considered unsatisfactory (see Figure 1). As Table 15 shows, differences between group means on the Map, Orientation, Wonderlic, and Army Physical Fitness tests were significant. The stepwise discriminant analysis showed that Map and APFT contributed uniquely to the criterion variance explained. Table 16 shows the classification efficacy of a discriminant function using a composite of these scores (weighted to maximize predictive power). As can be seen, the resulting success rate (the proportion of those predicted to be successful who actually were: 334/368=90.8%) is only slightly higher than the corresponding base rate (the proportion of the entire sample who were successful: 339/384=88.3%).

Phase II Board Evaluation. For these analyses, the 297 individuals selected to graduate from the SFAS program at its completion were considered satisfactory; the 32 remaining in the program at the end of Phase II but not selected for graduation were considered unsatisfactory (see Figure 1). Table 17 shows that the Maze test was the only significant predictor. The classification efficacy of a discriminant function using the Maze test is shown in Table 18. The resulting success rate (296/326=90.8%) is virtually identical to the corresponding base rate of 297/329=90.3%.

Successful Completion of SFAS. For this analysis, the 297 individuals who completed the SFAS satisfactorily formed the successful group (see Figure 1). The unsuccessful group was comprised of the 195 individuals who either dropped out of the program or were not selected for continuation by the Phase I or II review boards. All tests except General Technical had

Table 13

Spatial, General Cognitive, and APFT Scores as Predictors of Voluntary Attrition from SFAS Program

	Group					
	Remained N=374		Attrited N=93			
Predictor	M	SD	M	SD	t	Partial R^{2a}
Map	12.34	5.24	13.27	5.03	-1.54	NS
Orientation	15.46	6.15	15.68	6.30	-0.30	NS
Maze	18.56	3.86	18.60	3.56	-0.10	NS
Wonderlic	25.05	5.85	24.81	5.73	0.37	NS
General Technical	118.73	7.67	117.73	6.61	1.12	NS
APFT	235.37	24.94	225.06	26.55	3.52**	.031**

Note. *** p<.0001. ** p<.01.

The attritions voluntarily withdrew; remaining were those who graduated or were not selected at either board evaluation (medical and nonvoluntary withdrawals were not included).

[a] Shown for significant predictor after elimination of nonsignificant predictors, which are noted as NS; the partial R^2 is the total variance explained.

Table 14

Classification Efficacy of Discriminant Function Using APFT Scores To Predict Voluntary Attrition from SFAS Program

		Predicted Group		
		Attrited	Remained	Total
Actual Group	Remained	0	372	372
	Attrited	0	93	93
	Total	0	465	465
	Success and Base Rates		80.0%	80.0%

Table 15

Spatial, General Cognitive, and APFT Scores as Predictors of Successful Gate I Board Evaluation

	Evaluation					
	Successful N=341		Unsuccessful N=45			
Predictor	M	SD	M	SD	t	Partial R^{2a}
Map	12.67	5.05	9.89	6.14	3.39**	.026**
Orientation	15.77	6.10	12.84	6.16	3.02**	NS
Maze	18.64	3.89	18.04	3.32	0.98	NS
Wonderlic	25.34	5.73	22.67	6.71	2.88**	NS
General Technical	118.96	7.85	117.80	6.37	0.95	NS
APFT	238.58	22.65	211.93	28.05	6.11***	.120***

Note. *** p<.0001. ** p<.01.

[a] For significant predictors after eliminating nonsignificant (NS) predictors; total variance explained was .143.

Table 16

Classification Efficacy of Discriminant Function Using Map and APFT Scores To Predict Successful Gate I Board Evaluation

		Predicted Evaluation		
		Unsuccessful	Successful	Total
Actual Evaluation	Successful	5	334	339
	Unsuccessful	11	34	45
	Total	16	368	384
	Success and Base Rates		90.8%	88.3%

Table 17

Spatial, General Cognitive, and APFT Scores as Predictors of Successful Gate II Board Evaluation

	Evaluation					
	Successful N=297		Unsuccessful N=32			
Predictor	M	SD	M	SD	t	Partial R^{2a}
Map	12.85	4.91	11.13	5.84	1.85	NS
Orientation	16.08	5.83	13.34	7.63	1.97	NS
Maze	18.92	3.65	15.94	5.25	3.13**	.048***
Wonderlic	25.52	5.56	24.06	6.43	1.39	NS
General Technical	118.81	7.95	119.35	6.98	-0.36	NS
APFT	238.83	22.69	236.41	23.09	0.57	NS

Note. *** p<.0001. ** p<.01.

[a] For significant predictor after eliminating nonsignificant (NS) predictors; partial R^2 is total variance explained.

Table 18

Classification Efficacy of Discriminant Function Using Maze Scores To Predict Successful Gate II Board Evaluation

		Predicted Evaluation		
		Unsuccessful	Successful	Total
Actual Evaluation	Successful	1	296	297
	Unsuccessful	2	30	32
	Total	3	326	329
	Success and Base Rates		90.8%	90.3%

significant t-test results (see Table 19). However, in the stepwise discriminant analysis, only Maze and APFT accounted for significant proportions of unique variance in the criterion. Table 20 shows the classification efficacy of the discriminant function using a composite of scores on the Maze and APFT measures. As shown, the success rate of 253/373=67.8% is somewhat higher than the actual percentage of candidates who graduated (295/490=60.2%).

Discussion

Our results indicate that scores on the Project A spatial tests are moderately related to military orienteering scores, both in terms of satisfactory vs. unsatisfactory ratings and actual time scores. In this regard it is useful to note that the orienteering phase of SFAS is a "stress test" meant to measure candidates' ability to function in unknown and stressful situations as well as to apply certain navigation skills. Given that these variables, as well as differences in motivation, physical fitness, etc., impact candidates' orienteering scores, the moderate results for the spatial tests appear reasonable.

Whenever moderate effect sizes between predictor and criterion measures are encountered, the operational utility of the predictors is problematic. For example, how useful would the spatial tests be as selection screens administered during the first several days of SFAS? That is, can the tests be used to identify those individuals who would likely be failures at military orienteering? As shown in Tables 11 and 12, we found that the use of a composite of spatial and physical fitness scores to predict performance across <u>all</u> military orienteering tasks would result in an increase in the percentage of satisfactory performers. At the same time, 58 "nonselected" candidates (those predicted, on the basis of spatial abilities and physical fitness, to perform poorly actually performed satisfactorily. Thus, the benefits of using the composite as a screen - a higher proportion of acceptable candidates - must be viewed in light of the cost - rejecting a certain number of applicants who <u>would</u> have succeeded if chosen. The decision to use the composite in this manner then becomes a question of which error in prediction is more serious, accepting candidates who do not succeed or rejecting those who would.

This trade-off in errors of prediction is also relevant to the analysis of graduation rates, the only other discriminant analysis which yielded modest, but potentially useful results. As shown in Table 16, the use of an optimal combination of Maze and APFT scores as a screen would result in an increase in the proportion of candidates who graduate. However, there were also 42 "false negatives," or people who completed the SFAS program satisfactorily but were misclassified by the discriminant function as likely nongraduates.

Table 19

Spatial, General Cognitive, and APFT Scores as Predictors of Graduation from SFAS Program

	Group					
	Graduated N=297		All Others N=195			
Predictor	M	SD	M	SD	t	Partial R^{2a}
Map	12.85	4.91	11.85	5.68	2.00*	NS
Orientation	16.08	5.83	14.47	6.57	2.85**	NS
Maze	18.92	3.65	18.00	3.89	2.66**	.026**
Wonderlic	25.52	5.56	23.94	6.35	2.84**	NS
General Technical	118.81	7.95	117.99	6.82	1.19	NS
APFT	238.83	22.69	223.11	27.98	6.55***	.100***

Note. *** p<.0001. ** p<.01. * p<.05.

[a] For significant predictors after eliminating nonsignificant (NS) predictors; total variance explained was .111.

Table 20

Classification Efficacy of Discriminant Function Using Maze and APFT Scores To Predict Graduation from SFAS Program

		Predicted Group		
		All Others	Graduated	Total
Actual Group	Graduated	42	253	295
	All Others	75	120	195
	Total	117	373	490
	Success and Base Rates		67.8%	60.2%

Another important consideration is that the classification efficacies reported in this paper are likely to be overestimates, since the same samples were used to generate and test the discriminant functions (Dillon & Goldstein, 1984). A truer estimate of the classification efficacy of the functions derived from the present sample would be obtained if they were used to classify individuals from a different group of SFAS candidates.

In contrast to the moderately favorable results for predicting graduation and performance on military orienteering, analyses of the prediction of voluntary attrition and Gate I and II evaluations were more modest. A statistical explanation would be the high base rates for success, especially in the Gate I and II evaluations. That is, a high proportion of candidates are already being positively evaluated at these points (88.3% and 90.3%, respectively). It is unlikely that useful improvements can be made upon base rates that are this much above 50%, especially with the modest proportions of variance explained by the discriminant functions (Anastasi, 1982).

It is undoubtedly the case, however, that evaluations of candidates by others and candidates' own decisions to leave the program are based on many factors other than spatial, general cognitive, and fitness aptitudes. The role of motivation, for example, is perhaps especially important to an individual's decision to remain in the program or to drop out. It would appear, then, that the Project A spatial tests and other measures included in these analyses would be most useful in predicting attrition and evaluation outcomes when combined with measures of these other factors.

This last point speaks to the value of the research reported here. The modest effect sizes in our results indicate that performance in the SFAS program, including the military orienteering tasks, is a function of spatial ability and other, as yet unexplored, factors. Thus, although the present research does not provide a sufficient basis for recommending the use of Project A spatial tests as selection screens in the SFAS program at this time, it does provide a basis for pursuing further research which might identify a role for these tests in the selection process. Also, our findings should have heuristic value in any follow-up research into the determinants of success in the SFAS program as well as evaluations of the effectiveness of SFAS in screening candidates for admission into the Special Forces Qualification Course.

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